Physics Flash

November 2015

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INSIDE

Los Alamos NATIONAL LABORATORY EST. 1943

Recognizing achievement

Physics Division staff awarded for distinguished performance

Eighteen members of Physics Division received Los Alamos National Laboratory Distinguished Performance Awards, acknowledging their outstanding contributions in support of the Laboratory's programmatic efforts.

Individual award

Brenda Dingus

From 2010 to 2014, Brenda Dingus (Neutron Science and Technology Group, P-23) led and managed the High-Altitude Water Cherenkov Gamma-Ray Observatory (HAWC) collaboration team, which was comprised of approximately 140 scientists from 23 institutions in the United States and Mexico. She served as the Department of Energy's principal investigator of HAWC and managed its construction in a remote part of Mexico. HAWC is designed to study the origin of very high-energy cosmic rays and observe the most energetic objects in the known universe. Her vision, leadership, and management have helped Los Alamos become an internationally recognized leader in observational astrophysics.

Small team awards

Chi-Nu DAQ Team

Chi-Nu DAQ Team

The Chi-Nu project is a multi-laboratory, multi-year, and multi-million-dollar Campaign 1 experimental nuclear physics project with the goal to accurately measure the emission spectrum from neutron-induced fission on plutonium-239 and uranium-235. In January 2014, the existing Chi-Nu data acquisition (DAQ) system was unable to keep up with the data rate for the studies. In just six months, Shea Mosby and John O'Donnell (LANSCE Weapons Physics, P-27) designed, procured, coded, validated, and implemented a new highly capable, versatile DAQ scheme that positions the Chi-Nu project to meet its deliverables and provide required data.

Laser-Plasma-Instability Research Team

Laser-Plasma-Instability Research Team

As members of the Laboratory's laser-plasma-instability (LPI) research team, David Montgomery, Randy Johnson, and Tom Shimada (Plasma Physics, P-24), along with Lin Yin (Plasma Theory and Applications, XCP-6) and Brian Albright (XTD Primary Physics, XTD-PRI), made revolutionary advancements in the understanding of LPI, which established Los Alamos as a leader in the field, with their work appearing in the *Physics of Plasma* and being chosen as 1 of 14 "high-impact" published articles. Controlling LPI, which involves the interaction of intense laser light with a plasma, is vital to achieving thermonuclear ignition in the laboratory and fielding successful laser-driven, high-energy-density physics experiments at the National Ignition Facility.

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From David's desk . . .

"The 2015 Nobel Prize in Physics was awarded to Arthur McDonald, head of the Sudbury Neutrino Observatory (SNO) in Canada, and Takaaki Kajita, head of the Super-Kamionkande (Super K) experiment in Japan, for their work in discovering that neutrinos have mass. Los Alamos National Laboratory scientists played a significant role in the research that led to these awards."

The Physics Division has been performing research on neutrino physics for many decades. In the 1950s, Fred Reines and Clyde Cowan, Jr., led an effort that resulted in the first experimental proof that the elusive particle existed. Fred was awarded the Nobel Prize in 1995 for this discovery. Clyde would likely have received it as well, if he had been alive.

Jump to 2015: The 2015 Nobel Prize in Physics was awarded to Arthur McDonald, head of the Sudbury Neutrino Observatory (SNO) in Canada, and Takaaki Kajita, head of the Super-Kamionkande (Super K) experiment in Japan, for their work in discovering that neutrinos have mass. Los Alamos National Laboratory scientists played a significant role in the research that led to these awards.

The Physics Division connection

Los Alamos was instrumental in the design, assembly, and data analysis of the SNO experiment. Over 20-plus years—from the start of funding in 1990 to its final results in 2012—more than 30 Los Alamos scientists and technicians were involved in the SNO collaboration. One of the Laboratory's major contributions was the development and assembly of the neutral current detector array that operated in SNO from 2003 to 2006. It made an independent measurement of the total solar neutrino flux, which, in turn, confirmed its previous result that neutrinos have mass and change type between the sun and earth. Los Alamos also played major roles in delivering low-background photomultiplier tubes for the experiment, in creating a number of custom calibration sources used to calibrate the detector, and in data acquisition software and data analysis and simulations. Both current and past Los Alamos scientists and technicians contributed to the research.

Current Los Alamos employees who contributed to SNO are Tom Bowles, Michael Browne, Steve Elliott, Ernst Esch, Mac Fowler, Kate Frame, Keith Rielage, Laura Stonehill, and Richard Van de Water.

Past Los Alamos employees who also contributed to SNO are J. Manuel Anaya, Joe Banar, Steve Brice, Mark Boulay, Tom Burritt, Peter Doe, Emily-Michael Dragowsky, Noel Gagnon, Joe Germani, Azriel Goldschmidt, Andre Hamer (deceased), Jaret Heise, Andrew Hime, Klaus Kirch, Geoff Miller, Stan Seibert, Hardy Seifert, Miles Smith, Hamish Robertson, Nikolai Starinsky, Peter Thornewell, Jerry Wilhelmy, John Wilkerson, and Jan Wouters (deceased).

In addition, two current Los Alamos scientists contributed to the Super-K experiment. Christopher Mauger had a significant role in the calibration and simulation of the detector and received his PhD on neutrino oscillations from Stony Brook University. Todd Haines worked on Super-K's veto system, calibrations, and analysis. He started his work at the University of Maryland and continued it while an Oppenheimer Fellow at Los Alamos.

But this isn't the end of the story. The Physics Division continues to have a strong effort in neutrino physics. The Mini-CAPTAIN liquid argon time-projection-chamber (TPC) recently

continued on next page

From David's desk cont.

observed its first ionization track from a laser-calibration system (see story, this page). Mini-CAPTAIN will run in the high-energy neutron beam at the Los Alamos Neutron Science Center to measure the response of liquid argon TPCs to high-energy neutrons.

Other highlights

Three members of the Physics Division staff were recognized as fellows of the American Physical Society.

Division of Nuclear Physics

Andy Saunders

For contributions in developing proton radiography and the Los Alamos National Laboratory ultracold neutron source, enabling new applications of nuclear science and an improved understanding of the decay of the free neutron.

Division of Plasma Physics

Steven Batha

For pioneering investigations of forward scattering laser-plasma instabilities, hydrodynamic instabilities in high-energy-density physics regimes, and leadership of high-energy-density research.

Glen Wurden

For innovative approaches to plasma diagnostics applied to a wide variety of fusion confinement concepts, ranging from reversed field pinches to tokamaks to magneto-inertial fusion.

To read more on the new fellows, please see the story on page 6.

A number of Physics Division staff received 2014 Defense Program Awards of Excellence:

- *Leda Core Team*: David Holtkamp, John Smith
- *Leda Dynamic Surface Imaging Team*: Dan Sorenson, Pete Pazuchanics, Mike Ham, Josh Tybo, Jeremy Payton, Albert Hsu
- *Radiography Source Development Team*: Todd Haines, John Smith, Jeremy Danielson
- *Leda Imaging Feed-Through Team*: Dan Sorenson, Pete Pazuchanics
- *Radiometry Research and Development*: David Holtkamp, Benjie Stone

As well, Physics Division staff were recognized for their distinguished performances (for more details, please see the cover article).

Finally…..

The past month-and-a-half has been a whirlwind for me. I thank all those who have helped educate me, both about science and the culture here, and I thank you for making the time to do so.

Physics Division Leader David Meyerhofer

Mini-CAPTAIN snags first ionization track

Los Alamos detector paves way for international neutrino experiment

Mini-CAPTAIN, the prototype for the Cryogenic Apparatus for Precision Tests of Argon Interactions with Neutrinos (CAPTAIN), recently observed its first ionization track. The Mini-CAPTAIN detector is a liquid argon time projection chamber (TPC), a device capable of imaging charged particles through the trail of ionization electrons (ionization tracks) left behind when they interact with the argon nuclei. Its success makes it one of only a handful of liquid argon detectors now operating in the world. Liquid argon is increasingly being used as a detection medium by the worldwide neutrino community.

Under commission at Los Alamos, the 1,000-channel liquid argon TPC with 400-kg instrumented mass will use the Los Alamos Neutron Science Center's high-energy neutron beam, which is uniquely suited to aid understanding of how to reconstruct few-GeV neutrino interactions. The data are crucial to enabling larger and more complex neutrino experi-

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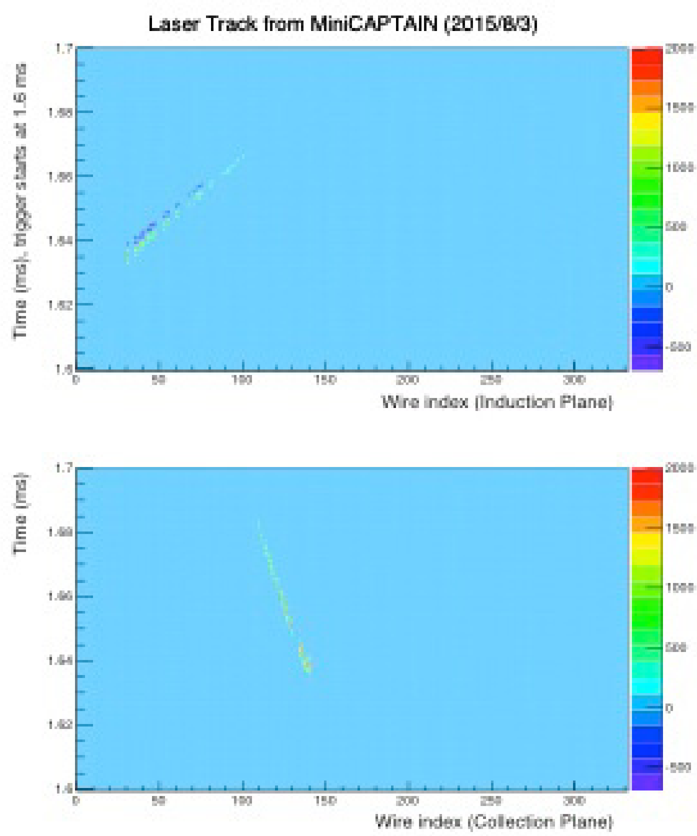

First demonstration of an ionization track from a laser calibration system in the Mini-CAPTAIN detector. Data, collected in August, were created with a high-intensity ultraviolet laser pulse traversing the time projection chamber. The color of the track represents the amplitude of the signal. Mini-CAPTAIN is currently running with one collection plane and one induction plane.

Distinguished cont.

Large teams awards

Project ATHENA Team

Pulak Nath, Henrik Sandin, and David Platts (Applied Modern Physics, P-21) were part of a team developing ATHENA (Advanced Tissue-engineered Human Ectypal Network Analyzer)—a system of linked surrogate human organs, miniaturized to fit on a desktop. In 2014, the team developed and linked two of the organs: the heart and liver. ATHENA will be used to assess methods of identifying and treating biological and chemical threats and to screen medicines, reducing the need for animal drug testing.

Legacy Lead Bricks Team

Mark Peters (P-21), Julian Lopez (Subatomic Physics, P-25), Steve Glick (Physics Division Office, P-DO) and Jeanette Gray (formerly P-DO), and Keith Rielage and Mitzi Boswell (P-23) were part of a team that repurposed 50 tons of legacy lead bricks. When Physics Division staff realized the bricks contained a type of lead useful for shielding in particle-physics counting experiments, the team safely moved the bricks—valued up to $3 million—and shrink-wrapped them, thereby saving a valuable resource for future scientific research and eliminating an environmental hazard.

LANSCE WNR Facility Recovery Team

Milestones for two NNSA Defense Program campaigns were at stake when damage from a water leak and a fire threatened to interrupt the Weapons Neutron Research facility run cycle. Pete Aguino, Greg Chaparro, Tim Medina, and Bill Waganaar (P-27) were among more than 40 employees who redesigned the WNR water system, built a replacement for the affected target, and replaced a 20,000-pound magnet, which had damaged coils, with two magnets. Beam was once again delivered on October 18.

Project ATHENA Team

Legacy Lead Bricks Team

LANSCE WNR Facility Recovery Team

Mini-CAPTAIN cont.

ments aimed at solving scientific grand challenges such as explaining the universe's matter-antimatter asymmetry.

Los Alamos researchers working on Mini-CAPTAIN include Christopher Mauger, Elena Guardincerri, Gerald Garvey, David Lee, Qiuguang Liu, William Louis, Jacqueline Mirabal-Martinez, Jason Medina, Geoffrey Mills, John Ramsey, Walter Sondheim, Charles Taylor, and Richard Van de Water (all Subatomic Physics, P-25); Keith Rielage (Neutron Science and Technology, P-23); and Gus Sinnis (then LANSCE Weapons Physics, P-27).

In addition, the CAPTAIN detector, a 5-ton instrumented mass liquid argon TPC with 2,000 channels, is under construction at Los Alamos and will eventually run at the Fermi National Accelerator Laboratory. The CAPTAIN program addresses important scientific questions associated with the long-baseline, atmospheric, and supernova neutrino science of DUNE. Dune (for Deep Underground Neutrino Experiment) is an international long-baseline neutrino program designed to aid neutrino science and proton decay studies. Los Alamos is developing and managing the DUNE detector systems.

The CAPTAIN program began as a Los Alamos Directed Research and Development (LDRD) program project with scientists in P-25, P-23, and Nuclear and Particle Physics, Astrophysics and Cosmology (T-2) performing work relevant to the long-baseline program. The development of the detector at Los Alamos led to the formation of a broad collaboration from institutes across the United States. Many external collaborators, especially graduate students and postdoctoral researchers, have spent significant time at Los Alamos working on the project. The CAPTAIN program continues to involve Los Alamos researchers from Physics and Theoretical groups. External CAPTAIN collaborators include the University of Alabama; Argonne National Laboratory; Lawrence Berkeley National Laboratory; Brookhaven

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Search for neutrinoless beta decay begins with MAJORANA DEMONSTRATOR

The MAJORANA DEMONSTRATOR (MJD), located 4850 feet underground in the Sanford Underground Research Facility in Lead, South Dakota, has recently started its search for neutrinoless double beta decay.

The MJD experiment studies the neutrinoless double beta decay of the nucleus in germanium-76. Observation of this process would provide valuable clues to why the universe is made of matter instead of antimatter and determine the mass of the neutrino. So far the process has not been observed. Neutrinos are fundamental particles that play key roles in the early universe, cosmology, astrophysics, and nuclear and particle physics. In late May, the first full module containing 29 detectors was moved into the lead/copper shield.

Module 1 contains 21 detectors that contain enriched germanium-76 with a total enriched mass of 16.8 kg and an additional 9 detectors composed of natural germanium with a total of 5.7 kg. Figure 1 shows the module during assembly with the 29 detectors arranged in 7 strings. The detectors are handled in nitrogen-purged gloveboxes to avoid exposure to radon in the air. The gloveboxes were designed and procured by Los Alamos in 2012. Figure 2 shows the module when it was removed from the module glovebox prior to being installed in the shield and a model of the module. A module contains a cryostat with the detectors, a thermosyphon to cool the detectors, supporting liquid nitrogen system, electronics, pumping systems, and part of the lead and copper shield. The entire module weighs approximately 8 tons and is moved between the gloveboxes and the shield by a mobile air-bearing table. The delicate movement of these systems was part of the Laboratory's contribution to the MJD project. The detectors in Module 1 are regularly calibrated using a thorium-228 source in a track around the cryostat. The calibration system was also part of Los Alamos's contribution to the MJD project.

The second module, with another 30 germanium detectors, is being assembled and will be moved into the shield sometime in late 2015. Previously, a prototype module with nine

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Figure 1. Assembly of the MAJORANA DEMONSTRATOR Module 1 detectors in the nitrogen-purged glovebox. Several of the strings of Ge detectors can be seen hanging in the copper cryostat.
Photo courtesy Sanford Underground Research Facility.

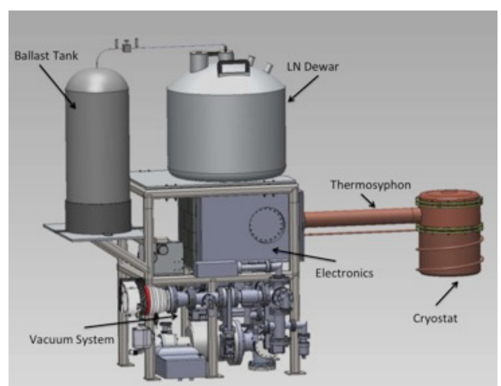

Figure 2. Above: Module 1 being moved on the air bearing table from the glovebox to the shield. Left: A model of the systems on Module 1.
Photo courtesy MJD Collaboration.

Mini-CAPTAIN cont.

National Laboratory; University of California, Davis; University of California, Irvine; University of California, Los Angeles; University of California, San Diego; Fermi National Accelerator Laboratory; University of Hawaii; University of Houston; Indiana University; Louisiana State University; University of Minnesota; University of New Mexico; University of South Dakota; South Dakota State University; and Stony Brook University.

This work is supported by the Department of Energy through the Los Alamos LDRD program and the Office of Science High Energy Physics, and the University of California Institute for Nuclear/Particle, Astrophysics and Cosmology. The work contributes to DOE Office of Science missions and supports the Laboratory's Nuclear and Particle Futures science pillar.

Technical contacts: Christopher Mauger, Elena Guardincerri

Physics Division scientists among newest APS Fellows

Steven Batha, Andy Saunders, and Glen Wurden were recently named fellows of the American Physical Society.

In the Division of Plasma Physics, Steve Batha (Physics Division, P-DO) was cited for pioneering investigations of forward scattering laser-plasma instabilities, hydrodynamic instabilities in high-energy-density physics regimes, and leadership of high-energy-density research. Batha, who earned a PhD in mechanical and aerospace sciences from the University of Rochester, joined the Laboratory in 1998 as a staff scientist in Plasma Physics (P-24). He is program manager of the Inertial Confinement Fusion and High Yield Campaign, overseeing studies of physics processes important for weapons science. He has served on numerous review committees for the Stockpile Stewardship Academic Alliance, National Laser User Facility, and other high-energy-density physics programs. Batha has received two NNSA Defense Program Awards of Excellence for neutron imaging diagnostics.

In the Division of Nuclear Physics, Andy Saunders (Subatomic Physics, P-25) was cited for contributions in developing proton radiography and the Los Alamos National Laboratory ultracold neutron source, enabling new applications of nuclear science and an improved understanding of the decay of the free neutron. Saunders, who received a PhD in physics from the University of Colorado, joined the Laboratory in 1998 as a postdoctoral researcher. He has participated in the development of proton radiography (pRad) since the early demonstration experiments conducted at Brookhaven National Laboratory in 1997; has led the Los Alamos pRad imaging capability since 2013; and served as the radiographer in charge of executing more than 150 explosively driven dynamic experiments at the Los Alamos Neutron Science Center for the weapons program, for which he is developing new techniques in charged particle radiography. Saunders also participated in the design and construction of the Laboratory's Ultracold Neutron Facility and is co-spokesperson of a project measuring the average lifetime of the free neutron. Saunders has received nine Defense Program Awards of Excellence and five Los Alamos Distinguished Performance Awards.

In the Division of Plasma Physics, Glen Wurden (Plasma Physics, P-24) was cited for innovative approaches to plasma diagnostics applied to a wide variety of fusion confinement concepts, ranging from reversed field pinches to tokamaks to magneto-inertial fusion. Wurden, who received a PhD in astrophysical sciences/plasma physics from Princeton University, joined the Laboratory in 1982 as a J. Robert Oppenheimer Postdoctoral Fellow. He leads P-24's Magnetized Plasma team, which uses a wide range of plasmas and plasma diagnostic techniques to understand complex processes in hot fusion plasmas. Recently, he collaborated with the Massachusetts Institute of Technology and the Air Force Research Laboratory on tokamaks and magnetized target fusion projects, and is fielding optical diagnostics on the long-pulse Wendelstein 7-X stellarator in Germany.

Majorana cont.

detectors was operating in the shield from June 2014 to May 2015 and provided valuable background data to improve the design and construction for Modules 1 and 2.

The MJD project has a goal of demonstrating that an extremely low background can be achieved equivalent to less than 3 counts from background per ton of germanium per year of operation in the energy region where a double beta decay signal would be. If such a background can be achieved then a larger-scale experiment capable of reaching a sensitivity of 15 meV for the neutrino mass is feasible in the near future.

The Los Alamos National Laboratory MJD team in Neutron Science and Technology (P-23) includes Steve Elliott (MJD spokesperson), Pinghan Chu, John Goett, Ralph Massarczyk, Keith Rielage, Larry Rodriguez, and Wenqin Xu. The glovebox was designed by Harry Salazar (Mechanical Design Engineering, AOT-MDE). In addition to Los Alamos, the experiment is being constructed by a collaboration of approximately 100 scientists from Black Hills State University, Duke University, Institute for Theoretical and Experimental Physics, Joint Institute for Nuclear Research, Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Osaka University, Pacific Northwest National Laboratory, South Dakota School of Mines and Technology, Tennessee Tech University, University of North Carolina Chapel Hill, University of South Carolina, University of South Dakota, University of Tennessee, and the University of Washington.

The experiment is supported at Los Alamos by the DOE Office of Science Nuclear Physics Program. The Los Alamos Directed Research and Development program funded early R&D that led to the successful proposal and experimental design. Additional project funds were provided by the National Science Foundation. The work supports the Nuclear and Particle Futures science pillar.

Technical contact: Steve Elliott

HeadsUP!

Improving our work control systems

Call for micro-experiment solutions

Todd Conklin worked at Los Alamos National Laboratory for 26 years, leaving in 2012 to work as a safety consultant to help organizations better understand and improve their human performance. After the arc flash event here this summer, he returned to the Laboratory as a consultant. He reviewed the event and others and presented a talk to senior managers. He told the managers that the Laboratory needed to change its definition of success. There are two key quotes from his slides as related to work control:

- “We have conflicting missions: my success is based upon world-class science. Their success is based upon ZERO risk.”
- The second was a challenge to managers: “You have a duty to produce a different outcome: perfection cannot be the expectation; you must design your systems with the capacity to recover. This is a deliberate management strategy.”

Conklin recommended that we look at our systems and then try what he called micro-experiment solutions. In other words, we are developing and piloting new ideas within ADEPS.

To deliver world-class science, ADEPS is looking to improve work control processes for R&D work. One proposal is to execute R&D skill-based activities without written instructions, instead using a qualification process.

A call for volunteers was made and the first activity of the group, the ADEPS team, was a video conference with Lawrence Livermore National Laboratory staff on their new work control initiative. After the conference, the team compiled a list of positive and negative attributes of the system relative to the needs at Los Alamos. The concept of a skilled worker was well received to reduce the need for work documents and to address the idea of “skill of craft” for worker qualifications.

Another well-received idea, although it goes against the idea of huge systems, was that Livermore has an online system tracking all requirements: work control, training requirements, worker qualification, RLM approvals, etc.

Since the video teleconference, Los Alamos has initiated an institutional effort to look at the integrated work management system. Mary Hockaday is leading that effort. In a note to the volunteer group, she wrote, “If we are going to live up to our dream and accomplish our greatest imaginable challenge, we need to change the systems that are limiting our ability to perform efficiently.”

Concurrent with the institutional effort, Hockaday has asked the team to brainstorm the biggest payoff activity we can do with our micro-experiment. If you have ideas or would like to join the team, please e-mail Howard Nekimken at hnek@lanl.gov.

Celebrating service

Congratulations to the following Physics Division employees celebrating service anniversaries recently:

Jon Kapustinsky, P-25	35 years
Chad Olinger, P-DO	25 years
Steven Elliott, P-23	20 years
Randall Johnson, P-24	20 years
Fesseha Mariam, P-25	20 years
Andreas Klein, P-25	15 years
Julian Lopez, P-25	15 years
John Ramsey, P-25	15 years
Takeyasu Ito, P-25	10 years
Ricardo Mejia Alvarez, P-23	5 years
Cesar Da Silva, P-25	5 years
John Dunn, P-24	5 years
Mike Schacht, P-23	5 years

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To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 505-606-1822, or kkippen@lanl.gov.

For past issues, see www.lanl.gov/org/padste/adeps/physics/physics-flash-archive.php.

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